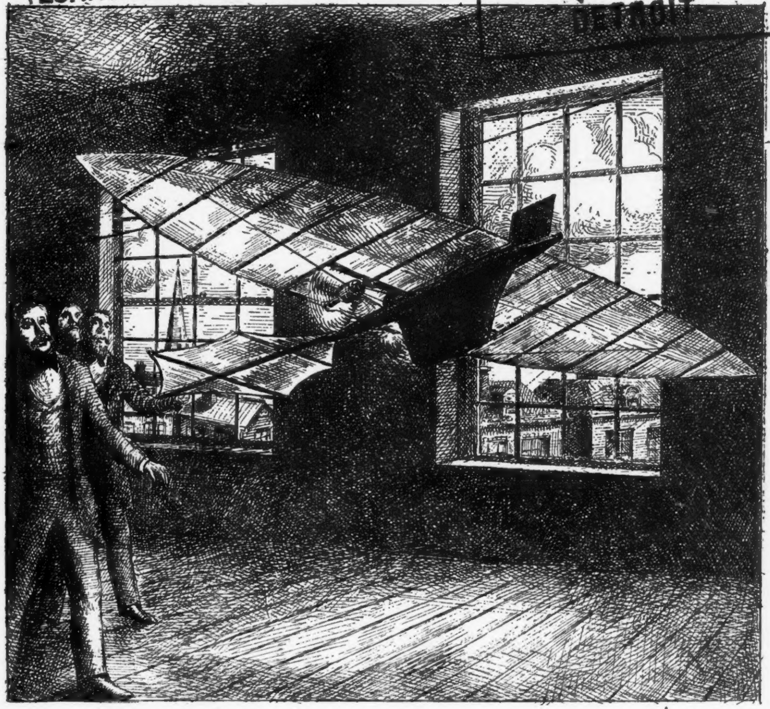
Light *and* Lighting

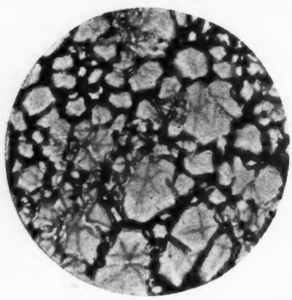
Vol. XLII.—No. 9 September, 1949 Price - One Shilling

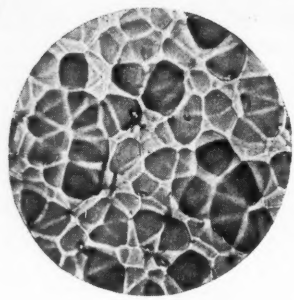


FIRST POWERED AEROPLANE. The first successful powered aeroplane was a model made by John Stringfellow. The forerunner of modern flying, it took the air for the first time in 1848 in a room at Chard in Somerset.

THE JOURNAL OF SEEING AND ILLUMINATION

Lighting Development and Research





A pearl lamp and photomicrographs of two stages in the pearling process. ABOVE: The glass after the first acid spraying. At this stage it is extremely fragile and will shatter at a touch. RIGHT: The same glass after it had been re-toughened by a second acid spray.

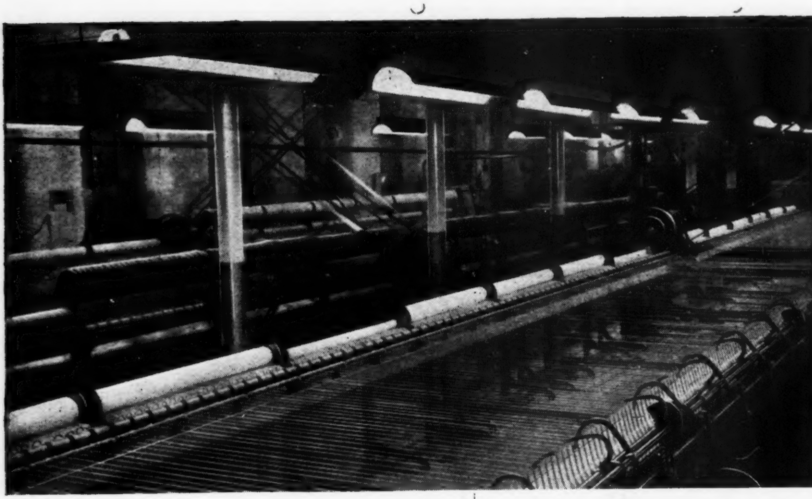
Pearling

Pearl bulbs were introduced to reduce the glare and eliminate or soften the hard shadow effect given by clear lamps. The only difference between the two is that the interior of the pearl bulb undergoes two acid-spraying processes to roughen the inside surface of the glass and thus form countless minute prisms, each refracting light in a different direction, and creating a degree of diffusion which conceals the brilliant lamp filament. The light appears to come from a bright patch on the bulb surface. This diffusion, which is a great advantage, particularly for most domestic lighting, does not result in any appreciable loss of light.

This process was originally introduced into this country by members of E.L.M.A and has added immeasurably to the seeing comfort of the nation.

The Lighting Service Bureau of the Electric Lamp Manufacturers' Association, 2, Savoy Hill, London, W.C.2.


CRYSELCO
FLUORESCENT
Lamps
IN
'NATURAL'
'WARM WHITE'
and 'DAYLIGHT'
MADE IN ENGLAND
COL CHRIS ELCO
PRICE LIST ON APPLICATION
BRANCHES
BIRMINGHAM
BRISTOL
BURY ST EDMUNDS
CARDIFF
GLASGOW
LEEDS
LEICESTER
LIVERPOOL
LONDON
MANCHESTER
NEWCASTLE
SOUTHAMPTON
CRYSELCO LIMITED KEMPSTON WORKS BEDFORD



Light and Lighting

32, Victoria St.,
London, S.W.1.

Telephone
ABBey 5215

Incorporating "The Illuminating Engineer."

Official Journal of The Illuminating Engineering Society.

Vol. XLII.—No. 9 September, 1949 PRICE ONE SHILLING
Subscription 15/- per annum, post free

CONTENTS

Making Seeing Easy

THOSE who are engaged in applying the art and science of lighting to make our seeing easy may not be more likely to suppose that good lighting is the only visual facilitator than oculists are to believe spectacles are the only means of aiding vision. Yet, preoccupation with one's own speciality leads easily to failure to appreciate what other means there may be to the end we have in view, as, also, to failure to call upon other specialists when our own limits are reached. So it is well to be reminded of this occasionally, and, accordingly, we publish this month the first part of an article dealing broadly with the subject of facilitating visual tasks and pointing out the essential unity of purpose which underlies the work of diverse people who have to do with the sight and the sights of others.

Illumination Notes and News

I.E.S. Student Members

Circulated with this issue of the journal is a list of I.E.S. members—a very useful document and one which was badly needed. Incidentally, the last list was issued in 1942, the lapse of time between issues being due to such matters as paper shortage, printing difficulties and the all-important question of cost.

Ignoring the great increase in members since the previous list was printed a noticeable feature of the new list is the very small number of student members of the Society. The number is certainly more than it was in 1942, but even so, for the size of the Society and considering the number of young men in the industry, the number is small indeed. As the subscriptions for students are quite low it would seem that the attention of our future lighting engineers has not been drawn to the advantages of joining the I.E.S. as students. Sustaining members of the Society and other firms in the industry would surely derive some advantage themselves by encouraging such young men on their staffs to join the I.E.S.; from the Society's point of view the encouragement of students will ensure that at least some of the coming lighting engineers will take an active interest in the Society from the start of their careers in the lighting field.

Also circulated with this issue is the programme of I.E.S. meetings during the coming session. In former years the programme has been published in the Transactions, but it is doubtful whether after a first glance it was ever referred to by the majority of members. By publishing it in brochure form it is thought that members will be able to carry the programme with them and be able to refer to it more easily. Similar brochures have, of course, been issued independantly by a number of the centres and groups in the past.

I.E.S. members might, in looking through the programme, consider whether their younger, and no doubt some of their older, colleagues would not gain some benefit from being able to take part in I.E.S. activities.

Next I.E.S. Sessional Meeting in London

The opening meeting of the new I.E.S. Session will be held at the Royal Society of Arts, John Adam Street, London, W.C.2, at 6 p.m., on Tuesday, October 11.

At this meeting the new President, Dr. J. N. Aldington, will be introduced and will present his presidential address. Dr. Aldington is director of research to Siemens Electric Lamps and Supplies, Ltd., and is well known for his work on light sources, a subject on which he has published numerous papers.

I.E.S. Visit to N.P.L.

The I.E.S. London programme for next session includes on October 25 a visit to the National Physical Laboratory. It is understood that the visit will be a general one and that a number of interesting places in the Laboratory, in addition to the Light

Division, will be visited. The visit is to start at 2.30 p.m. at Teddington. Those wishing to take part should apply to the I.E.S. Secretary, 32, Victoria-street, S.W.1.

Eyestrain and Artificial Light

It should be reassuring, to anyone who still doubts the harmlessness of fluorescent lighting, to know that it is installed in some of the last places we should expect to find it if it were injurious to the eyes or the general health. To mention only a few of these significant places in the London area, there is the Institute of Ophthalmology, which is associated with the combined Moorfields, Central London, and Royal Westminster Eye Hospitals and, going westward from thence, the London School of Hygiene, in the fluorescent-lighted lecture theatre of which members of the I.E.S. have listened to more than one presidential address. Then there is University College Hospital, and, more westward still, The Royal Society of Medicine. North and south of these examples other notable instances are to be found, such as the National Institute for Medical Research at Mill Hill, the Ministry of Health in Whitehall, and the headquarters of the Medical Research Council overlooking St. James's Park near the Cockpit Steps.

We commented last month on the statement of a contributor to another journal that, "it is well known that artificial light is one of the major causes of eyestrain." A current advertisement for a certain lighting unit in a widely read journal contains the advice that "as all artificial light is harmful to the eyes, try to use as little of it as you can conveniently do with." A nineteenth-century Chancellor of the Exchequer is remembered for his proposal to make "a little profit out of light" (ex luce lucellum) by taxing matches. The twentieth-century has presented us with someone who, presumably, hopes to make a profit out of a little light! Speaking for ourselves, if we believed that "all artificial light is harmful to the eyes" the business of selling even a little of the nasty "stuff" would not be ours by choice, though we might entertain the idea of marketing crystal palaces. Less regrettable than publication of astonishing statements of the kind referred to above, are the out-of-date and the "scrambled" statements about lighting which make their appearance from time to time in books by well-meaning but not so well-informed authors. Our attention has been drawn to some recent examples of this misfortune, and it is certainly a pity that every author who ventures into print on a subject which is not his own does not get his writing vetted before publication.

Planning for Daylight

Addressing the British Association for the Advancement of Science at Newcastle this month, Prof. Dudley Stamp called attention to what may become a serious consequence of our present practice in building only eight or ten houses per acre of land. In the Victorian period, as Prof. Stamp reminded his listeners, sometimes about sixty houses were built to the acre. While not, of course, approving such overcrowding, the speaker pointed to the loss of food producing capacity entailed by the use of land for building at the housing density now thought to be desirable. There are various grounds upon which a low housing density can be advocated, and one of them is that it allows good daylighting. But a number of important factors have to be taken into account in planning for interior day-lighting, and Prof. Stamp's address reminds us that in this, as indeed in much more of our planning, the "long term" effects of what we do should not escape consideration.

The Use of Sinusoidal Webs in Plotting Light Distributions from Fluorescent Lamp Fittings

By H. J. TURNER, B.Sc., A.M.I.E.E., F.I.E.S.*

Many lighting fittings with filament or high pressure mercury vapour lamps are built with a vertical axis of symmetry, and their light distribution is usually expressed in terms of a system of angular co-ordinates, the principal axis of which is vertical. The fitting is suspended on a vertical axis so that it lies on the horizontal axis of rotation of a system of mirrors. By this, or equivalent, means the fitting can be "viewed" at all angles in a vertical plane by a photocell, for it is equivalent to moving the photocell round a great circle† of an imaginary sphere centred on the fitting similar to a line of longitude. If then the fitting is rotated about its vertical axis by, say, 10 deg. and the photometry repeated, the photocell will now move relatively to the fitting round another great circle also containing the vertical axis of the sphere but displaced from the first by 10 deg. The process may be continued until the whole space round the fitting has been explored by measurements made on a series of great circles all containing the vertical axis, which is thus the principal axis of the system.

The sphere is represented by the circular web shown

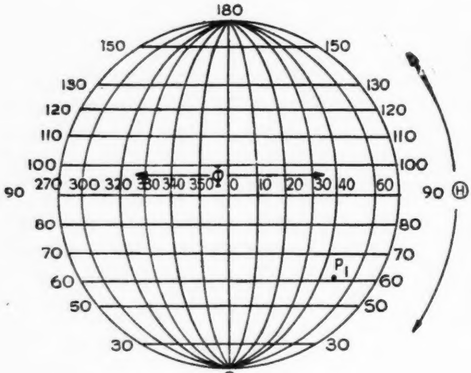


Fig. 1a. *(Above)* Projection of a series of great circles on a sphere surrounding a fitting, with the principal axis vertical.

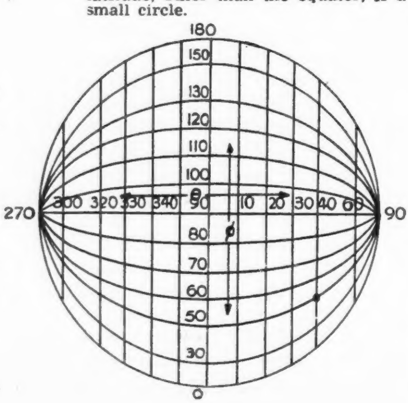


Fig. 1b. *(Right)* Projection of a series of great circles on a sphere surrounding a fitting, with the principal axis horizontal

* Formerly of the Research Laboratories of The General Electric Company, Limited, Wembley, England.

† A great circle is a circle drawn on the surface of a sphere, the diameter of the circle being also the diameter of the sphere. The equator of the earth is a great circle. A "small circle" is one whose diameter is not a diameter of the sphere; a line of latitude, other than the equator, is a small circle.

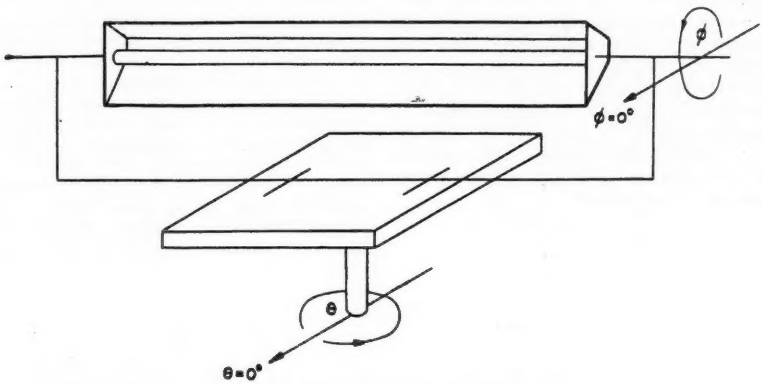


Fig. 2. Frame and turntable for the photometry of fluorescent lamp fittings. (Diagrammatic.)

in Fig. 1a, where the vertically running curved lines represent the great circles. The horizontal lines, similar to lines of latitude, provide a scale of angles through which the cell moves in the vertical plane of any particular great circle. In Fig. 1a "vertical" angles, defining movement on any great circle, are denoted by Θ and the scale of "horizontal" angles, defining rotation of the fitting about its vertical axis, are denoted by Φ.

Apparatus made for measurements of this kind is not normally suitable for the photometry of 5 ft. fluorescent lamp fittings because of their length. For these fittings it is often more convenient to use a system of co-ordinates, the principal axis of which is horizontal instead of vertical. The fitting can then be mounted on a frame so that it can be rotated about its long horizontal axis. The frame is mounted on a turntable so that frame and fitting can be rotated about a vertical axis. This arrangement is shown in Fig. 2 where the angle of rotation of the fitting about its long axis is described as ϕ and the angle of rotation of the turntable as θ. The photocell is placed at a suitable distance on a level with the horizontal axis of the fitting. The turntable is set, by rotation about its vertical axis, to a convenient angle; and the fitting is then rotated about its horizontal axis and readings taken. This arrangement is equivalent to keeping the fitting stationary and moving the photocell first, when $\theta = 0$ deg., round a great circle of a sphere centred on the fitting normal to its horizontal axis. Then, as by rotating the turntable θ is set to 10 deg., 20 deg., 30 deg., etc., rotating the fitting about its horizontal axis is equivalent to moving the photocell round small circles on the same sphere, similar to lines of latitude on a world turned on its side. When $\theta = 90$ deg. (or 270 deg.) the cell is facing the end of the fitting. This sphere is shown in Fig. 1b, where the vertical lines represent the small circles on the sphere and the horizontally running curved lines define angles of movement round these circles.

Thus the more convenient method of photometry leads to a method of plotting which is not usual and is to some extent, therefore, inconvenient. However it is not difficult to transform the results from one form of web to another, as follows. The web shown in Fig. 1b is of course the same as that of Fig. 1a turned on its side. It is evident that corresponding points on the two spheres define the same direction in space, but this direction will be expressed by different, but related and equivalent angles on the two networks. If the position of a point P is defined (for

example) by the angles $\phi = 50$ deg. and $\theta = 40$ deg., it will be found by measurement on the diagrams that the corresponding point P_1 is defined by the angles $\Theta = 48$ deg. and $\Phi = 61$ deg. approximately. These angles can be found more exactly from a large, accurately drawn web on which both sets of lines are drawn. Alternately, they are given by the relations:—

$$\cos \Theta = \cos \phi . \cos \theta$$
$$\tan \Phi = \tan \theta / \sin \phi$$

sinusoidal web* usually employed for showing the complete light distribution from a fitting. If a fluorescent lamp fitting is photometered in the way described, taking readings at angular intervals of 10 degrees, the intensity values can be written down on the 10 degree angle intersections of a sinusoidal web data sheet (or "onion" diagram) turned on its side. The isocandle lines are then drawn in as usual by interpolation between these values. With the diagram resulting it is, of course,

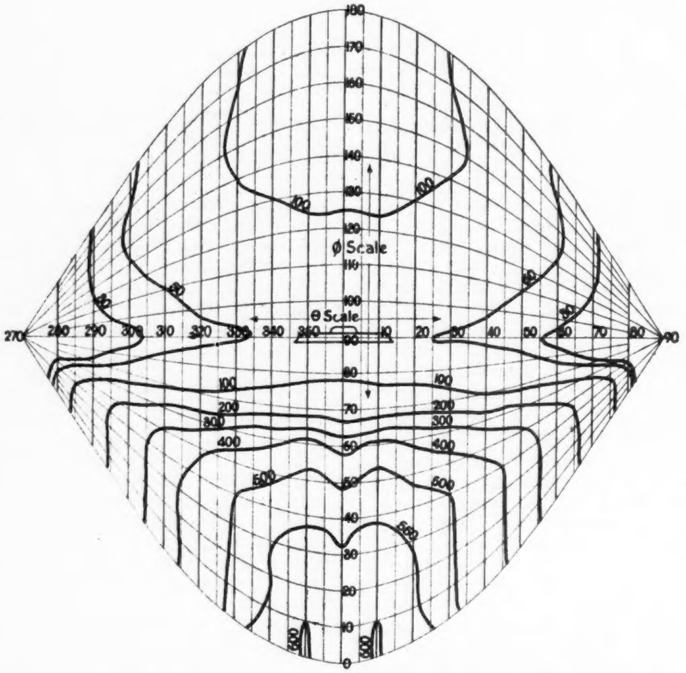


Fig. 3. Isocandle diagram of a fluorescent lamp fitting drawn on the horizontal plotting web.

whence, for example, if $\phi = 50$ deg. and $\theta = 40$ deg., then $\Phi = 60.5$ deg. and $\Theta = 47.6$ deg. For a given set of θ and ϕ values a table can be drawn up giving the corresponding Θ and Φ values.

These arguments apply equally to the possible to calculate light flux by measurement of areas, for the "equal area" feature of the sinusoidal web is not changed. If, however, it is required

* The best description of the construction and use of the sinusoidal web is by Dr. Walsh in "Public Lighting," Vol. 9. No. 33. April-June, 1944.

to obtain polar curves of light distribution for vertical planes through the vertical axis of the fitting when suspended in the normal way, the isocandle lines are replotted, by the method described above, on a second data sheet used vertically in the way in which they are usually printed. It will be appreciated that had the webs of Figs. 1a and 1b been used, the isocandle lines would be identical in the two cases, for Figs. 1a and 1b represent the orthogonal projection of a sphere with two different reference webs drawn on it. But the isocandle net is a conventional representation of the sphere and introduces distortions not identical in the two cases. The lines must thus be replotted by their co-ordinates. Figs. 3 and 4 show two isocandle distributions of the same 80-watt fluorescent lamp fitting, Fig. 3 drawn on a "horizontal" plotting web and Fig. 4 on a normal "vertical" web.

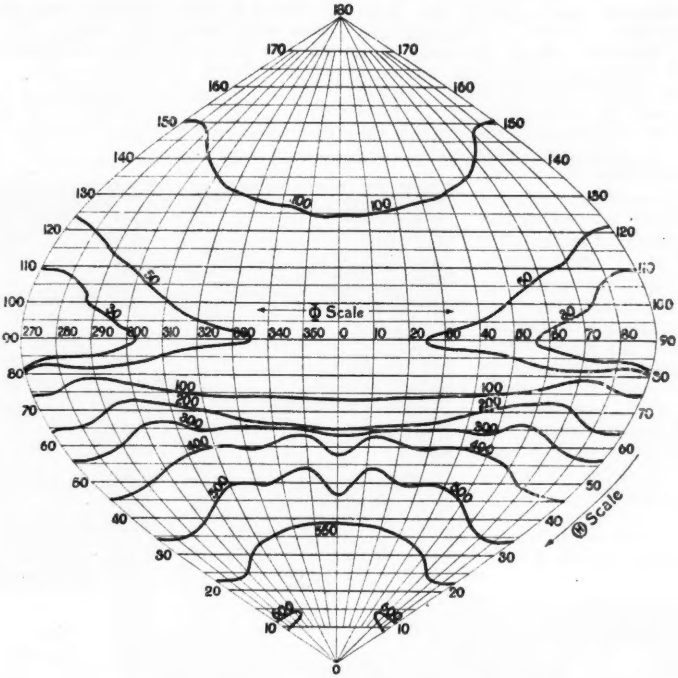


Fig. 4. Isocandle diagram of a fluorescent fitting drawn on the normal vertical plotting web.

Courses for C. & G. Exams.

In addition to the information regarding courses given in our last issue details are now available of courses arranged at the Leeds College of Technology where arrangements have been made for students to study for both the Intermediate and Final Grades.

The Inter. course will be an evening one, classes being held from 6.30-9.0 p.m. on Mondays and Wednesdays. The course begins on September 26, the fee being 42s.

The final course, which is for both section "A" and section "B" is a part-time day and evening course, classes being held on Friday afternoons and evenings. This course begins on September 30, the fee again being 42s.

Further details may be obtained from Dr. E. C. Walton, head of the Electrical Engineering Dept., College of Technology, Cookridge-street, Leeds, 1.

Lighting and Decoration in a Canteen

London Transport Training Centre

A modern training centre for canteen staff has recently been opened by London Transport next to Baker-street Station. The centre occupies the entire first floor of the new building, the ground floor being occupied by a new staff canteen seating over 150 people.

The training centre is in two main divisions—the general demonstration kitchen and the pastry kitchen—each with an adjoining classroom, enabling both theoretical and practical training to be given. By means of large windows and the skilful use of glass bricks the best use is made throughout the building of natural light.

The illustrations of the canteen and of one of the classrooms of the training centre show the single tube lighting fittings mounted direct on the ceiling. The illustration of the classroom also shows the use of glass bricks to improve daylight conditions. The majority of the artificial lighting in the building is fluorescent, half the lamps being warm white and half natural colour.

The interior finishings have been carried out in hygienic and hard-wearing materials. Kitchens are laid with buff terrazzo and the canteen dining-room with a pattern of two shades of green terrazzo. Classrooms and corridors are covered with linoleum in buff squares with black borders. The staircase walls are finished in green terrazzo and the canteen walls in eggshell tiling. The walls of the three kitchens are finished in cream glazed tiling.

The building was designed by London Transport architects and the lighting designed and installed by their engineering department.

(Above) Showing one of the classrooms.

(Left) The canteen.

METHODS OF FACILITATING VISUAL TASKS

By H. C. WESTON

[Part I]

This article contains the substance of the 23rd Ettles Memorial Lecture delivered by the author in October, 1948, to the Association of Optical Practitioners. Dr. W. J. W. Ettles, M.D., F.R.C.S.E., who was an Ophthalmic Surgeon and Pathologist to the Royal Eye Hospital, London, became a member of the Illuminating Engineering Society in 1910.

Those who, in diverse ways, are engaged in what I may call the management of *sight* and *sights* have a unity of purpose. Whether they be optical practitioners, oculists, lighting engineers, optical instrument makers, or whether they be those who design visual aids to education, advertisements, books, displays of merchandise, theatrical and cinematograph "shows," and soon, all of them strive—more or less consciously, and with different mixtures of empirical and scientific knowledge — to facilitate vision. Their common business is to make it easy for others to see things. I believe that a more conscious realisation of this common aim is desirable among all who work—in whatever particular direction—to ease visual tasks, and that none of these workers should lack interest in those methods not of his own speciality by which visual perception can be facilitated. My aim, therefore, in this lecture is to draw attention to the variety of aids to vision, and to illustrate the importance of some of them by reference to the results of certain investigations.

"The sense of our eyes," said Plato, "is most acute in us; but yet we do not see wisdom with them." But the wisdom of trying to facilitate vision has been apparent to men throughout the ages. Among the ancients, Cicero, for instance, wrote of the need for removing everything which could impede or hinder the senses. Of easing visual tasks in particular, he said, "therefore we often wish the light to be changed, or the situation of those things we are looking at; and we either narrow or enlarge distances; and we do many things until our sight causes us to feel confidence in our judgment."

Centuries later—at the beginning of the eighteenth century to be precise—Ramazzini, the father of industrial medicine, was greatly concerned about the severity of the visual tasks of those who are regularly employed in doing fine work—watchmakers and the like. He recommended that they should wear spectacles while at their work but, also, that they should have frequent respites from it, so as to rest the eyes upon distant views. His advice is as sound now as it was then.

In our own time, work involving much accommodation and convergence of the eyes, which, of course, is what Ramazzini meant by "fine work," is much more widespread than it was in his day; and to enable such work to be done without this heavy load upon the visual mechanism is now a matter of correspondingly greater importance.

Yet it is astonishing how often fine work is done without the ocular aids that would prevent eyestrain in doing it, as well as how many people overlook the need, which Cicero appreciated, for removing things which hinder vision.

Task Analysis and Grading

The most intelligent application of methods of facilitation is only possible when the nature of an occupation—so far as it involves vision—is known quantitatively. The "work," considered as sights, needs to be assessed and graded in terms of the demand it makes for various visual capacities. Unless we know what sights are characteristic of an occupation, and unless we "take the measure" of what an analytical study of the job discloses to be the "key sights," we have no quantitative basis for the prescription of facilitators, any more than we have for the prescription of corrective glasses unless the refraction of the eyes is measured. Nor—without studying the work—can we know what method, or methods, of facilitation it will be best to use, nor even whether certain methods are feasible at all in a given case.

The characteristics of visual occupations which it is most important to ascertain are (a) the distance of what is to be seen, i.e., the distance of the objects in the key sight; (b) the size of these objects, or their occupationally significant components or "details"; (c) the brightness and colour of these objects and of the immediate surroundings with which they must be in contrast if they are to be discriminated. Usually, the chief difficulty in job-analysis is to ascertain just what is the critical detail the operator has to see, for, often, this is no "thing" that would, ordinarily, be listed in a complete inventory of the things looked at. It is impermanent and fugitive, being created by the approximation of one object to another just before some consummatory action is performed by the operator. This is so in assembly jobs, of which the homely task of threading a needle is one; whereas, with inspection jobs—such as reading—the critical detail is stable and measurable without great difficulty.

Jobs may be classified or graded, on account of the severity of their demands upon vision, on the basis of each of the characteristics I have mentioned. Previous suggestions for this classification have assumed that it should primarily be on the basis of object-size. The Departmental Committee on Factory Lighting, in their third Report (1922), distinguished three grades of work, "ordinary," "fine" and "very fine," taking the size of detail to be seen, or the limits of precision to which the operator has to work, as the criterion for grading. But the primary classification is better done in terms of viewing distance, which tells us more about the demands of the job upon visual resources than does the size of the objects of view. There can be "fine" work at long as well as at close range, but the resources the worker must have differ in these two cases.

But, if jobs are classified on the basis of viewing distance, how are we to describe the different classes it is desirable to distinguish? We are, of course, very familiar with the expression "near work." By this we really mean occupations involving *near sights*—the inspection of things which are very close to the eyes. But what of occupations which are chiefly characterised by distant views, such as transport vehicle driving, seafaring, farming and others? These cannot properly be called "distant work," and it would be cumbersome—although correct—to call them "work involving distant sights." The difficulty is even greater for that very large class of occupations involving the inspection of objects which are neither far from, nor very near to, the eyes. We cannot speak of "intermediate-distance-work," nor does the expression "work-at-arm's-length" commend itself, for it lacks both brevity and any direct reference to vision.

To meet this difficulty I have, elsewhere,* adopted a consistent and accurately descriptive terminology, respectably derived from the Greek.

Now we have long since adopted the word "panorama," which is formed by the Greek prefix "pan"—meaning "all," and "horama" (ὅραμα) — meaning "that which is seen, a view or sight." It is a very convenient word when we wish to refer to the view all round. I have taken the same root word—"horama"—and added the Greek prefixes necessary to define the distance of "that which is seen," so obtaining the three words "telorama," "mesorama," and "ancorama." From these are derived the adjectives "teloramic," "mesoramic," and "ancoramic which describe those classes of occupation, or work, which it is useful to distinguish,

*"Sight, Light and Efficiency." H. K Lewis and Co., Ltd., 1949.

not only with reference to methods of facilitation, but also in connection with the selection of suitably sighted personnel.

Teloramic work is that which calls for practically no habitual accommodation and convergence, and so includes all occupations in which the viewer generally looks at objects not less than six feet from the eyes. Mesoramic work is that which habitually involves a moderate degree of accommodation and convergence, and so includes all jobs in which the viewer is generally engaged in looking at objects within six feet, but not within one foot of the eyes. The majority of indoor occupations belong to this class, and it includes ordinary reading. Ancoramic work (Fig. 1) is that which calls for the frequent or prolonged accommodation of emmetropic eyes to the extent of four dioptres or more, and it is to occupations in this class, and in the preceding one, that I chiefly refer in what follows.

The appraisal of occupations in respect of other demands than those upon the ocular muscles ought to be as precise as possible. Assessment of the apparent size, i.e., angular subtense, of the objects which have to be seen is clearly important. When we know this, we know what degree of acuity is necessary to do the work, and in ascertaining the distance of the work-sight we obtain one of the dimensions needed for calculating this requirement. But if we only knew that an occupation involves the perception of things that look small we could not tell from this whether it involves much or little ocular muscle effort, though it is this feature of the job by which we must assess it as an "eyestrain risk."

The Means of Facilitation

(i) *Lighting.*

The first method of facilitating visual tasks to which I shall refer is that of lighting, for, since there can be no visual tasks without light, this is clearly the primary facilitator.

It is common knowledge that we experience more or less difficulty in seeing different objects according to the prevailing level of illumination. It is understandable, therefore, that since the conditions of lighting desirable for

Fig. I.

different kinds of work have been the subject of research—and that is only in the past few decades—a leading question to which an authentic answer has been sought is, What is sufficient illumination for the work, having regard to the prevention of eyestrain and the efficient performance of the work? To answer this question various experimental industrial and laboratory studies have been made, and what we now know concerning the relationship between illumination and visual performance is sufficient to enable definite levels of illumination to be recommended with considerable confidence in their adequacy. Such recommendations are now embodied in lighting "codes," of which the most comprehensive in this country is that prepared by the Illuminating Engineering Society, though there are others, dealing with the lighting of dwellings and schools, which have been issued by the Ministry of Works Codes of Practice Committee through the British Standards Institution.

A very brief reference to a few of the investigations which have been made must suffice here to indicate the limitations of lighting as a means of facilitation. In 1920, Elton made a careful study of the output of silk weavers during the winter months, and found that there was a steady improvement from January to March. Now, during this period, there is also a steady increase in the duration and intensity of daylight, and from actual records of daylight illumination, taken by the National Physical Laboratory, it can be shown that the trend of the weavers'

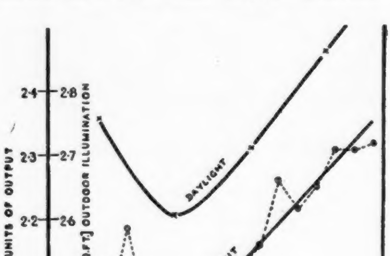


Fig. 2.

output corresponds very closely to the daylight illumination trend. This is plainly shown by the curves plotted in Fig. 2.

It can also be shown that at the time when the output curve flattens out the illumination of the work was of the order of 40 lumens per sq. foot (or 40 foot-candles). From my own study of the efficiency of linen weavers, made a little later, a similar conclusion can be drawn, that is to say, that the weavers' work continues to be facilitated up to an illumination level of 40 to 50 lm/ft.². Much later (1938) I was able to show that the efficiency of worsted weavers, working entirely by artificial light, did not come to a maximum until the illumination on the cloth was raised to about 30 lm/ft.². Weston and Taylor, in 1926, showed that the work of printing compositors becomes easier as the illumination of their type and copy is improved up to a value of about 25 lm/ft.². A study of the illumination required for clerical work, made by McDermott in 1937, points to the conclusion that about 20 lm/ft.² is desirable for the work of typists.

Lythgoe's classical work on visual acuity was published in 1932 and, as is well known, he showed that acuity continues to improve even when the illumination exceeds 1,000 lm/ft.², and he pointed out that the lace workers of Geneva work out-of-doors when they can, presumably because the very high illumination thus secured facilitates their difficult visual task. In my own laboratory studies of the relationship between illumination and visual performance (1935 and 1945), it was shown that, with very difficult inspection tasks, facilitation is continued up to 500 lm/ft.². Fig 3 gives a graphical summary of the results obtained, and it can be seen how the desirable illumination intensity varies according to the size of detail that has to be discriminated, and the degree of contrast by which this detail is revealed.

The curves of Fig. 3 also show the extent of the facilitation that can be achieved by means of illumination, but it will be noted that large changes of illumination do not lead to proportionately large changes in visual performance. Further, it may be noted that, no matter how high the illumination is made, it is impossible to make the visual task of perceiving very small

detail, or detail that contrasts very poorly with its background, so easy to see as are objects which are twice as large, or are in much better contrast. These experiments also showed that, within the wide range of illumination values used, a given increment, say a doubling, helps some individuals much more than others, probably because, apart from their refraction, their visual fitness for the work is inferior. In consequence of this, as the illumination of the work is increased more and more, the performance of the less efficient workers progressively approaches that of the more efficient individuals, though equality may never be reached.

The level of illumination on the actual work is not, however, the only factor in lighting which affects the facility of vision. The general level of illumination is also important, as Lythgoe showed, and it should be such that there is no great diversity of brightness between the objects of attention and other parts of the objective field of vision. Excessively bright areas within the field of vision—usually represented by the light sources themselves—cause glare, and so hinder vision. But glitter from polished articles—which may be the actual work-objects—also causes glare, and Wyatt and Langdon have shown how much the work of women working with brass cartridge cases is facilitated when diffuse daylight is available, instead of an unsuitable arrangement of artificial lighting causing glitter.

Special methods of lighting have to be devised to facilitate certain tasks, owing to the nature of the work-objects and the kind of detail which has to be shown up, or to the situation of the work-sights, which makes them inaccessible to light provided only by a system of general lighting. Many examples might be given, but the method of illuminating the fundus of the eye by means of the ophthalmoscopic mirror is an outstanding example which requires no description to optical practitioners. It is, of course, not the only special method of lighting devised and utilised before the emergence of illuminating engineering as a speciality. Because it is essentially similar to a method of lighting the eye developed earlier in ophthalmological practice, a special method of lighting used for the inspection of polished tin-plate, and the

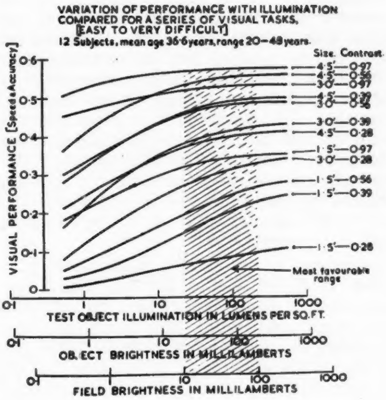


Fig. 3.

like, is worth mentioning here. A local illuminator is used consisting of a lamp in a suitable housing provided with an opal glass visor, on which is painted a number of parallel black bars. A definite pattern of light is thus projected on to the tin-plate, but the pattern seen by the viewer is distorted if the surface of the plate is irregular. Similarly, a pattern of light is projected on to the cornea by Placido's disc for the purpose of detecting asphericity.

Another example may be mentioned, as illustrating the utilisation of one of the most recently developed light sources. Because of the fumes associated with a gas-burning machine used for making glass bases for radio valves, a large conical hood, for exhaust ventilation, has to be suspended above the machine. This prevents the parts the operator has to see receiving an adequate share of light from the general light sources. The difficulty has been overcome by mounting, inside the rim of the hood, a ring-shaped cold-cathode fluorescent lamp. By this device, all the operator's points of view are well illuminated without any glare from the "tailor-made" lamp.

(ii) *Youth.*

Quite a different factor affecting the facility with which visual tasks can be done is age. Yet, as this is a factor which also affects the level of illumination required, it will be convenient to deal with it at this stage. That certain ocular

changes occur as age advances is, of course, very well known, and these reduce the facility of vision. The recession of the near-point, the yellowing of the lens and loss of transparency of other media, are among these changes, though, for most of us, they are not momentous until we are middle-aged or actually elderly. The difficulty of the near-point can be overcome by the use of spectacles, and, to some extent, the effect of other changes in the eye can be offset by more light.

Ageing, however is a continuous process, and the visual system which undergoes it comprises much more than the eyes. Although the truth of these statements is obvious enough, and the early commencement of decline in accommodative power is a well-established fact, most of us do not suspect that any measurable decline in our performance of critical, though not unreasonable, visual tasks occurs during the third and fourth decades of life. Nor is this surprising, since the decline is insidious, and may not, in fact, be measurable by familiar visual tasks, which virtually become less critical with experience.

But, in a recent paper* I have presented data showing that, for a series of visual tests requiring the discrimination

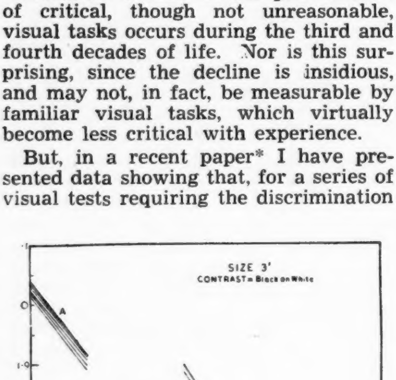


Fig. 4.

* The Effect of Age and Illumination upon Visual Performance with Close Sights. Brit. Jour. Ophthal., 1948, 32, 645-653.

of detail ranging in size from 1.5 to 4.5 minutes of arc, performance is inversely proportional to age as the latter varies from 20 to 47 years. Fig. 4 is reproduced from this paper. It relates to five groups of subjects, each differing in age within the range just mentioned. The size of the detail presented for discrimination was three minutes of arc, which is characteristic of that in newsprint; and it can be seen that the performance declines from one age-group to the next, and at an annual rate similar to that exhibited for each group by comparison of the quinquennial performances of its members.

These tests were performed at six different levels of illumination, so that the results obtained show how variation of illumination affects the facility with which the visual tasks could be performed by persons of different age. As Fig. 4 plainly shows, performance is more and more affected by illumination as age increases, but high illumination does not give as good performance at the age of 40 as low illumination gives at half this age. Other things being equal, youth, then, is a potent facilitator of visual tasks; " alas—that Youth's sweet-scented manuscript should close "!

(iii) *Ophthalmological Means*

The ophthalmological means of facilitating visual tasks include everything, by way of treatment or ocular adjunct (spectacles), which can be applied to the visual-defective so as to remove, or reduce, his handicap. Their importance is fully appreciated by optical practitioners, but I believe the effects of their application have seldom been made the subject of industrial investigations, as have the effects of lighting. Shortly before the recent war an attempt was made to ascertain what effect the correction of minor errors of refraction in women doing close work would have upon their efficiency at work. But, as often happens in such investigations, unexpected changes in the working conditions made a valid comparison of performance impossible, though most of the subjects who had low degrees of hypermetropia said their work was easier when they wore their corrections. Weston and Adams, however, found that a very considerable increase in individual efficiency followed the correction of larger errors of refrac-

tion, though only a few cases were available for study.

Though correction of refractive errors frequently gives the subject better acuity, it has not been found that the efficiency of those doing fairly exacting visual tasks in industry is determined primarily by their acuity. That is to say, in the case of a group of operators doing work requiring, say, at least 6/9 vision, it has been found that though the individuals in the group had different acuities—none, of course, being below the minimum required—the correlation between acuity and job-efficiency was low. However, not enough data are available to justify any generalisation on this matter, but what I have said should cause no surprise if it is remembered how many other visual factors have to be taken into account, and especially that the performance of particular visual tasks depends upon the next facilitator I want to mention.

(To be concluded)

Forthcoming I.E.S. Meetings

LONDON

October 11th

Sessional Meeting. Presidential Address by J. N. Aldington. (At the Royal Society of Arts, John Adam Street, W.C.2.) 6 p.m.

October 25th

Visit to the National Physical Laboratory (tickets only). 2.30 p.m.

November 8th

Sessional Meeting. Messrs. M. W. Peirce and D. J. Reed on "Specialised and General Lighting in Hospitals." (At the Lighting Service Bureau, 2, Savoy Hill, W.C.2.) 6 p.m.

November 23rd

Informal Meeting. A Brains Trust—with a difference. Question-master—Kenneth Horne (At the Lighting Service Bureau, 2, Savoy Hill, W.C.2.) 6 p.m.

CENTRES AND GROUPS

October 3rd

Mr. A. H. De-Ritter on "The Lighting of Road Transport Vehicles." (At the Medical Library, The University, Western Bank, Sheffield, 10.) 6 p.m.

October 5th

Chairman's Address by Mr. A. J. Ogle. (At the Minor Durant Hall, Oxford Street, Newcastle-on-Tyne.) 6.15 p.m.

October 6th

Mr. H. W. Cummings on "The Gas Arc—A New Light Source." (At The Agricultural House, Queen Street, Exeter.) 7 p.m.

October 7th

Mr. H. W. Cummings on "The Gas Arc—A New Light Source." (At the Grand Hotel, Bristol.) 7 p.m.

October 7th

Chairman's Address by Mr. P. Hartill. (At the Imperial Hotel, Temple Street, Birmingham.) 6 p.m.

October 7th

Dr. W. J. Wellwood Ferguson on "Colour." (At the South Wales Electricity Board, Demonstration Theatre, The Hayes, Cardiff.) 5.45 p.m.

October 7th

Miss M. D. Wardlaw on "Lighting in the Home." (At the Electricity Showrooms, Market Street, Huddersfield.) 7.15 p.m.

October 10th

Mr. E. E. Faraday on "Light, Colour and the Stage." (At the Priestley Hall, City Square, Leeds.) 7.30 p.m.

October 11th

Chairman's Address, by Mr. C. C. Smith. (At the Lecture Theatre, Merseyside and North Wales Electricity Board's Showroom, Whitechapel, Liverpool, 1.) 6 p.m.

October 13th

Mr. E. B. Sawyer on "Illuminating Engineering in America. (At the Demonstration Theatre, East Midlands Electricity Board, Leicester Sub-Area, Charles Street, Leicester.) 6.30 p.m.

October 13th

Mr. I. Quigley on "Mine Lighting." (Joint Meeting with the Manchester Geological and Mining Society.) (At the Reynolds Hall, Manchester College of Technology, Sackville Street, Manchester.) 6 p.m.

October 20th

Mr. C. H. Edlin on "Light and Other Radiations in Criminal Investigation." (At the East Midlands Gas Board Demonstration Theatre, Parliament Street, Nottingham.) 5.30 p.m.

October 26th

Mr. T. S. Jones on "Textile Factory Lighting." (Joint Meeting with the Electrical Contractors Association). (At the Welfare Club Hall, City of Edinburgh Lighting and Cleansing Dept., High Street, Edinburgh.) 7 p.m.

October 27th

Mr. T. S. Jones on "Textile Factory Lighting." (Joint Meeting with Dundee District Electric Society.) (At Dundee).

October 27th

Mr. F. G. Copland on "Analysis of Lighting Problems in an Industrial Undertaking." (At the Institution of Engineers and Shipbuilders in Scotland, 39, Elmbank Crescent, Glasgow, C.2.) 7 p.m.

October 27th

Mr. P. J. Corry on "Lighting and the Visual Art of Stage Production." (At the Yorkshire Electricity Board, 45-53, Sunbridge Road, Bradford.) 7.30 p.m.

November 1st

Mr. T. S. Jones on "Shop Window Lighting." (At the Lecture Theatre, Merseyside and North Wales Electricity Board's Showroom, Whitechapel, Liverpool, 1.) 6 p.m.

November 2nd

Mr. A. W. Jervis on "Department Store Lighting." (At the Minor Durant Hall, Oxford Street, Newcastle-on-Tyne.) 6.15 p.m.

November 3rd

Mr. J. F. Roper on "School Lighting." (Joint Meeting with the Cardiff Branch of Electrical Associations for Women.) (At the South Wales Electricity Board Demonstration Theatre, The Hayes, Cardiff.) 5.45 p.m.

November 3rd

Mr. W. A. R. Stoyle on "The Operation and Maintenance of Fluorescent Lamp Installations." (At the Agricultural House, Queen Street, Exeter.) 7 p.m.

Lighting at the Coal Face in British Mines

*Summary of a paper by Mr. R. Crawford, Chief Electrical Engineer, National Coal Board, presented to the National Association of Colliery Managers, at Cardiff, June 2, 1949.**

This subject is one which has aroused considerable interest amongst lighting engineers, due to the fact that the complexities and problems associated with its successful application are not easily solved.

Several interesting papers dealing with various aspects of the problem have been presented from time to time, but it was the purpose of the paper summarised below to review the overall position to date and to analyse some of the results already obtained from the experimental installations now in service.

The case for good general lighting underground has been stressed many times in the past, and if it is accepted that the provision of adequate lighting is warranted on the inbye sections of the more important roads, then surely the same applies to the most important of the working areas, the coal face itself.

The results of the early efforts to introduce face lighting in this country are probably well known, but the origin and aims of the experiments now being carried out may not be so familiar; for this reason a few words on these points may be justified.

Origin of the Present Experiments

The present-day trial installations were originated by the Sub-Committee on Coal Face Lighting, Mechanisation Advisory Committee, Ministry of Fuel and Power, who held their first meeting during May, 1946.

As it was considered that the advent of the commercial, mains-voltage fluorescent lamp in small sizes provided a new approach to the problem and also offered a good opportunity to make a fresh attempt to introduce mains lighting at the coal face, the Sub-Committee met with the following terms of reference: "To investigate the application of fluorescent discharge lamps to coal face lighting; to develop the design of flameproof fittings for this type of lamp; and to study the most suitable arrangements of fittings and cables."

The original Committee, comprising representatives of the trade associations concerned, the Mines Inspectorate, the Safety in Mines Research Board, the British Colliery Owners' Research Association, the coal owners, and the Ministry of Fuel and Power, confined their early considerations to the design and development of suitable flameproof lighting units. Eventually two such fittings were designed and manufactured, and it is these units (with small alterations) which are in use to-day. It was natural that this work should take some little time, and it was not until after vesting date, when the work of the original Sub-Committee was taken over by the Illumination Committee of the National Coal Board, that the first trial installations were planned and actually put into commission.

In order to provide the widest variety of conditions at the coal face it was decided to select up to 10 collieries in different parts of the country which had seams not less than 3 ft. thick, and, for the purpose of reliable comparative data, each with a control face having as nearly identical conditions as possible and employing portable lighting.

The importance of using control faces in each colliery where the experimental installation was introduced has been well demonstrated. At Colliery "B," for example (see Table 1), an increase in output on the fluorescent lighted face was offset by a similar increase (for some other reason) on the control face where no change in the lighting conditions had taken place.

Review of the Experimental Fluorescent Lighting Installations

At the present time some seven or eight fluorescent lighting installations are in use and generally are giving satisfactory service. In addition, one experimental installation of fluorescent lighting units of the air-turbo (pneumatic-

*(Acknowledgment is made to the National Coal Board for permission to publish these extracts.)

TABLE I.

Coal-face Fluorescent Lighting—Installation Data.

Colliery	Seam thick-ness, ft.	Face length, yds.	No. of fittings in use.	Average spacing of lights, ft.	Average distance from lights to face, ft.	Lamp size, watts.	Couplers.	Shot-firing.	Initial date of instal-lation.
"A" (mains fed)	2 to 7	80	17	15	7	15 w. & 30 w.	Between each light	No	20.8.47
"A" (air-turbo)	2 to 7	80	17	15	6	30 w.	—	No	20.8.47
"B"	4	90	21	12	9	40 w.	Between each light	Yes	5.4.48
"C"	2 to 4	70	18	12	7	15 w.	Between each light	Yes	3.5.48
"D"	4	100	25	12	9	15 w.	Between pairs of lights	Yes	5.12.48
"E"	5.5	110	26	12	10	30 w.	Between each light	Yes	25.8.48

electric) type is also in operation. It will be appreciated that the number will vary from time to time as faces work out or mining difficulties are encountered. Table 1 gives some indication of the variety of conditions under which the mains lighting is operating. All are in longwall conveyor faces employing coal cutters, and shot firing is practised on all but two installations.

Although, as previously mentioned, it was the original intention to limit the experiments to faces in seams not less than 3 ft. in height, some have since deteriorated, and, in one case, parts of the face are now as low as 2 ft.

Although it has been necessary to make modifications to suit particular local conditions, a more or less standard assembly of cables and fittings has been adopted. It was originally decided to mount the fittings in the line of cable rather than use the alternative of tee-joint boxes together with short wander cables, and so far as the fluorescent lamp is concerned, this decision appears to have been correct.

Policy regarding the use of cable connectors (provided to facilitate moving-up and the replacement of a damaged fitting or length of cable) has not yet been finally determined, but experience seems to show that a coupler between every lighting unit is preferable to having one between every two or even three fittings. In the early stages trouble was experienced with the cable attachments in both the couplers and fittings, but this has now been overcome in the majority of cases. The actual position of the fittings in relation to the conveyor varies, but in general it is the practice to locate and support these on the back row of props.

In most cases careful records have been kept of all items affecting maintenance and the general performance of any particular experimental installation. For example, an analysis of the operational experience relating to lamp life shows that of the total number of lamps reported as having failed, 14 per cent. had a life of less than 100 hours; 18 per cent. failed between 100 and 500 hours; 20 per cent. failed between 500 and 1,000 hours; 31 per cent. failed between 1,000 and 2,000 hours, and 17 per cent. failed between 2,000 and 3,000 hours. Although there was some difficulty in the early days of the trial installation due to premature lamp failures there has been a material improvement during the past few months and a reasonable average life is now thought to be 1,750 hours, but, of course, this must be further improved on.

Information has also been obtained of damage to fittings as a result of shot firing. On one face in a 4-ft. seam where 21 fittings are in service and where during the life of the installation an average of about 650 shots have been fired within 7 ft. of each fitting, only 14 units have sustained damage in varying degrees, and in most cases only the "Perspex" enclosures were affected. A new technique is now employed in the pressing of one type of cover which is expected to result in substantially greater strength. This, coupled with better protection of the fittings during shot firing by the proper use of shields or aprons, should again minimise the risk of damage.

Illumination Standards

Illumination surveys have been carried out on a number of the experimental installations at regular intervals, and typical results are quoted in Table 2.

The Technical Advisory Committee

recommended a level of general illumination throughout the working area of the order of 0.4 $lm/ft.^2$, but it will be observed that under the worst conditions, that is, midway between lamps, the illumination value falls short of this figure. However, it will be appreciated that this is a function of the lamp watts, the spacing between lamps, and the distance from the lamps to the face, all of which are variable. Nevertheless, the diversity factor is good when compared with the best that portable lamps can offer.

Economics

As yet it is not possible to assess accurately the cost of fluorescent lighting on a tonnage output basis mainly because of the experimental nature of the present installations, their fairly limited scope, and the relatively short time they have been in commission. Furthermore, the lighting fittings now in use bear a large proportion of the development costs and it is reasonable to assume that there will be a fairly substantial reduction in price as and when the demand increases and they are manufactured on large-scale production lines.

On the present basis, the capital cost per 100 yards of face lighted varies between £800 and £1,000, depending on the type of lighting unit selected and the actual spacing adopted along the face. However, the price range quoted above is typical of the present installations and includes all equipment up to and including the gate-end transformer.

Assuming a reasonable life for the components of a fluorescent face lighting installation, the costs to cover annual depreciation would appear to be of the order of 0.8d. per ton, whilst the operational costs inclusive of repairs, maintenance, and the daily move-over (but neglecting power costs) vary between 1.02d. and 1.44d. per ton. The power costs, amounting to approximately 0.1d. per ton, are almost negligible when taking into account the other charges.

The air-turbo lamp installations show a slightly lower capital cost, but the running costs, neglecting power consumed, amount to 1.5d. per ton, which is somewhat higher than the mains-fed installations.

Summarising the data available at the time of writing, it appears that the cost of face lighting on the lines of the existing experiments amounts to a capital expenditure of £800-£1,000 per 100 yards of face and a total running cost of 2d. to 2½d. per ton.

Alternatives to Fluorescent Lighting

The early attempts to introduce coal face lighting and the difficulties associated with the use of metal filament lamps must be well known. However, although the present experiments are in the main confined to lighting by means of fluorescent lamps, it is not intended to reject the possibility of successfully applying tungsten lamps for this application. In fact, one such installation of fittings with hemispherical internally serrated glass covers which are amber tinted is now on trial. In this installation which employs 50-volt 40-watt lamps, the lighting units are attached to wander cables, which are in turn joined up to the main cable run by special vulcanised-in connectors.

It has been suggested that some

TABLE II.

Illumination Surveys of Experimental Fluorescent Face-lighting Installations.

Colliery.	Type of lighting unit.	Date of illum. survey.	Approx. average distance from lamps to face at time of survey, ft.	No. of lamps surveyed.	Illumination on coal face in lm/sq. ft.			
					Av. of values opp. lamps.	Range of values opp. lamps.	Av. values mid-way between lamps.	Range of values mid-way between lamps.
"A"	15-watt and 30-watt (mains fed)	March, 1949	7	9	0.49	0.84–0.16	0.15	0.35–0.03
"A"	30-watt (air-turbo)	March, 1949	6	6	2.30	6.40–0.49	0.18	0.37–0.11
"B"	40-watt	January, 1949	9	20	0.68	1.34–0.11	0.38	0.59–0.22
"C"	15-watt	May, 1948	6	12	1.79	2.58–1.23	0.31	0.77–0.14
"D"	15-watt	December, 1948	8½	23	0.31	0.75–0.08	0.21	0.48–0.05
"E"	30-watt	November, 1948	7 to 16	26	0.45	0.79–0.09	0.15	0.24–0.07

entirely new thought should be given to the design of suitable fittings for face lighting with tungsten lamps, and it is thought that the present fluorescent lighting experiments may provide a very definite clue in this connection. A new type of low brightness fitting for use with tungsten lamps is now in the prototype stage and is being developed for coal face lighting.

The Future of Coal Face Lighting

It has been roughly estimated that the introduction of general lighting at the coal face throughout the industry would involve the National Coal Board in capital expenditure of the order of £5,000,000, and in addition may subsequently add 2½d. per ton or more to the price of coal. These figures should, however, be accepted with caution.

A higher standard of face maintenance and practice would undoubtedly result, and should be reflected in straighter face lines, better packing and timbering, and should also considerably facilitate the daily moving over of the conveyor. Of the economic benefits derived from the experimental installations very little can be said at the moment, since, if the results are to be of any value, a further period of time is necessary to collect and evaluate data on the experimental and comparative control faces.

From the humanitarian aspect alone, particularly the benefits reflected in the better general health of the miner, coal face lighting may be more than justified. The interest displayed by the workers themselves is encouraging, and already requests have been made for the extended use of fluorescent lighting at more than one colliery. In theory, at least, it follows that better seeing conditions should result in higher efficiency, if only because of the reduction in wasted effort which is undoubtedly associated with bad lighting.

Increased output has been obtained and indeed sustained from the face in at least one of the experimental installations, and in more than one a reduction in minor accidents has been recorded.

However, it is clear that as yet sufficient experience has not been gained to enable all the relevant factors to be definitely established one way or the other. Furthermore, the equipment at present employed could perhaps be improved, and also a good deal more thought must be given to the daily moving-over procedure. For these reasons, and if ultimate failure is to be avoided, strict control will continue to be exercised over the development of coal face lighting.

Consideration has been given to the introduction of coal face lighting on every face in one carefully selected pit, as it is believed that one such large-scale experiment would establish the pros and cons more effectively and more definitely than the present scattered experiments. Those who are mainly concerned with the nystagmus problem and with improving the general health of the underground worker, and who plead that conclusions as to the future of coal face lighting should be reached as quickly as possible, would no doubt support this recommendation. However, the failures of the past should not be forgotten, and the need for extreme caution and patience now and in the future must be appreciated.

Much valuable information has been gained since the inception of the present experiments, and generally the results obtained are encouraging. Undoubtedly some progress has been made towards the establishment of general lighting at the coal face as a practical proposition and given the willing co-operation of those at the mine, together with the skill of the Illuminating Engineer and some optimism, there are definite prospects of success once the major difficulties are finally overcome.

E.L.M.A. Design Courses

Illumination Design Courses arranged by the Lighting Service Bureau to take place in London and in the Provinces during the coming winter are as follows:

London, Monday evenings, Oct. 3-Nov. 7.
Darlington, Tuesday evenings, Sept. 20. Oct. 18.
Cleethorpes, Wednesday evenings, Sept. 21-Oct. 19.
Birmingham, all day, Sept. 27-30.
Southampton, Tuesday evenings, Oct 4-Nov. 1.
Bristol, Thursday evenings, Oct 6-Nov. 3.
Manchester, evenings of Oct. 12, 19, 27.
Liverpool, evenings of Oct. 13, 18, 26.
Swansea, Tuesday evenings, Nov. 1-22.
Newcastle, Oct. 20, Nov. 11, Feb. 10, March 10.

Applications for places on these courses should be made as soon as possible to the Lighting Service Bureau, 2, Savoy Hill, London, W.C.2.

Problems in Illuminating Engineering For Students

By S. S. BEGGS, M.A., F.I.E.S.*

I. The City and Guilds of London Institute's Examinations.

Introduction

At present there is a great scarcity of text-books, and almost no other published material which can form a guide to students who wish to study the technical side of Illuminating Engineering, whether it be solely for their own better understanding of the subject and its application in their work, or whether it be for a specific examination such as those of the City and Guilds of London Institute. The preparation of text-books and courses of instruction requires considerable energy and time, so that, although there are good hopes that the number of books which will be of direct use to the student will gradually increase, and that courses of instruction will in time become more readily available to students throughout the country, at present many students, and especially those who have passed beyond the intermediate stage, must rely largely, if not entirely, on their own unaided studies at home. It has been suggested that, to meet this period of predominantly private study, and perhaps also to be of help to the technical college teacher of this subject, who is not himself in personal contact with this branch of industry, a series of " worked examples "—in the old phrase of the text-book—would be welcome; it has even been suggested that some of the more expert practising lighting engineers would find interest in reading another fellow's solution of a problem. This series of notes has therefore been prepared primarily for the student who is studying for the City and Guilds of London Institute's examinations in Illuminating Engineering, but is being published here because of the wider field of interest which it is believed to have.

* Research Laboratories of the General Electric Company, Ltd., Wembley, England.

Scope of the Series

The main difficulty in a series such as this is to know how to select and treat the material available to the greatest advantage in the time and space available. There are some general rules, which apply to either intermediate or final grade, and these merit discussion; but the detailed answers to questions will have to be restricted. As the new syllabus for the intermediate grade of the C. and G. examination is much more explicit than the original, and as there has already been published an excellent text-book which covers this grade, the intermediate grade student is fairly well catered for, and his need for additional help of this kind is relatively small. If an attempt were to be made to cover the whole of the final grade syllabus, either the series would be too protracted to be of use to a student, or it would be too sketchy to give him any material help. Probably the majority of candidates for this examination are associated with industry, supply authorities or similar bodies, whose work is more concerned with light sources, lighting equipment and lighting installations than with radiation physics, physiological optics and advanced photometry (such as is the concern of the standards laboratory). *It will be of more real benefit to the majority of students, therefore, to consider for the present only Section B of the C. and G. examination syllabus;* it is much preferable that the student should have a thorough understanding of the part of the subject with which he is concerned in practice than that he should have a smattering of the whole subject or a purely theoretical knowledge of the side with which he has little or no opportunity of contact. It is emphasised most strongly that the student should seek every opportunity of studying actual light sources, equipment and

lighting installations, and should relate the information given in books and papers to his own first-hand experience. Only in such a way will he become a really well-qualified lighting engineer—however many examinations he may have passed.

In the remainder of this article a comparison of the intermediate and final grade examinations will first be made to help the student to determine the extent of the subject matter and the type of approach that is required in each; and, secondly, some general guidance on examination technique will be given, in the hope that it may save from unmerited relegation the student who knows the subject well but is unused to or unnerved by a public examination.

In subsequent articles of the series a selection of questions which have been set in the final grade Section B examination in previous years will be discussed briefly and an example of a suitable answer to each given. It will be appreciated that the number of questions that can be treated is very limited but an attempt will be made to select those which are fairly typical of the kind of question to be expected, and which best illustrate the important considerations to be borne in mind in the subject matter of the question.

Comparison of Intermediate and Final Grade Studies

It should be made clear that the views expressed here are in no way official but are the outcome of experience in both the academic and industrial lighting fields and have already proved of help to students for these examinations.

If the originally published syllabuses of the intermediate and final grade examinations be compared the difference may not appear very great; the impression may be left that the final grade is merely harder questions on the same material as the intermediate grade.

Nor does a study of the papers set in previous years always make the difference apparent, for sometimes very similar questions have been set in the intermediate and final grade examinations. In reality the content of the syllabus of the final grade is intended to be rather wider than that of the intermediate grade (for example, the latter does not include any heterochromatic photometry, nor the design of projection apparatus); in addition, the type of answer expected is very different, even when the questions appear very similar.

In the intermediate grade what is required is a knowledge of the nature of light, the fundamental characteristics of vision, the basic principles and methods of light measurement, and the essential characteristics of light sources, lighting equipment and lighting practice. The emphasis throughout is on the basic scientific facts upon which the lighting industry relies. Detailed or specialised application of these facts is not required, for this is information which should be equally valuable to the photometrician, ophthalmologist, lamp manufacturer, fittings designer or lighting engineer. As an example, a knowledge of the existence and meaning of the standard luminosity curve for the light-adapted eye is essential, and acquaintance with the nature of the change involved at low levels of brightness leads easily to appreciation of the Purkinje effect; but a knowledge of the exact values of the ordinates or expert ability to determine the light output of a source or the reflection factor of a coloured material from the spectral energy curve of the radiation is not necessary at this stage (but the appreciation that it can be done is desirable). The simpler standard equipment in common use and examples of good lighting practice should be known, but again an appreciation of their important characteristics rather than particular features of one instrument, lighting fitting, or installation is what is required.

For the final grade the approach is not so much along the lines of the fundamental principles as their application in the photometric laboratory or in good illuminating engineering practice. The candidate in this examination should be able to carry out a photometric investigation, test lighting equipment, design a lighting fitting or plan a lighting installation with reliability and success; he need not be an expert in all branches of the subject, but he should have an understanding of the general requirements in each field and be able to discuss a proposed scheme or procedure intelligently with the experienced expert.

(The experience can be gained only by practice.) He cannot be expected to know all the detailed information given in the advanced reference books available, but in his answer to a question he should endeavour to show intimate personal acquaintance with the subject of the question—without mere padding or digression from the actual question —as the examiner is not very impressed with obviously mere book-learning. Particular designs, unless of an almost universally accepted type, will not be required; but the student should not only know the principles but should be able to describe at least one example of their application to a practical design. That is where the study of lighting designs and techniques met with in the course of daily life will prove of particular assistance. These points will probably be clearer from the discussion of particular questions in later articles in the series. One important result is that in the final grade examination there are often several correct answers to a question, and only one that is quite wrong; the candidate must avoid the last at all costs, or even an approach to it, but nevertheless he still has a wide choice, and apparently widely different answers may all score full marks.

Examination Technique

There is always an element of tension in an examination, and candidates with the requisite knowledge not infrequently fail due to lack of an understanding of how to make the best use of the limited time available. It is essential to complete answers to a sufficient *number* of questions, for however well-disposed, the examiner cannot give more than full marks for any one question. It is therefore very important for the candidate to make sure he has a watch or clock available, and to limit the time he spends on any one question, even though he must leave it incomplete. Read the question *carefully* before answering it, and make sure you give the information asked for and not something else; this advice seems obvious, but the number of intelligent students who make this error is surprisingly large. Read the question again after you have finished, and make sure you have answered the *whole* of it. Time is short, so be concise and do not digress; a clear rough sketch is better than an elaborate drawing to scale that conveys no more information, but it must be accurate. Treat the examiner as a colleague requesting information—which, of course, you know—and remember he is as eager for you to succeed worthily as you are.

I.E.S. Informal Meeting

The first I.E.S. informal meeting in the session about to begin is announced as "a Brains Trust with a difference." As readers may wonder what the difference is to be we have ascertained that instead of the questioner having to be satisfied (or not, as the case may be) with the answers given by the "experts," at this meeting questioners will be allowed to ask supplementary questions—they may, indeed they are almost encouraged, to argue with the experts if they don't like their answers.

As the meeting is an informal one it is intended that the evening should be enjoyable as well as instructive and it is not intended that it should be as solemn as Brains Trusts so often are. The panel of "experts" includes Mr. R. O. Ackerley, who, we think, can be guaranteed to have an answer to any question; Mr. J. G. Holmes, who has frequently put life into otherwise tedious discussions; Mr. L. H. Hubble, who has taken part in previous informal meetings, and Mr. N. C. Slater, who will be representing the provinces. The final member of the team, and the one who will have to control the other members, is the question-master, Mr. Kenneth Horne.

Members wishing to submit questions should send them to the I.E.S. Secretary; the questions should be typed or written on a sheet of paper bearing nothing else except the senders name, address and signature. It will be assumed that those submitting questions will be present in person at the meeting. At the meeting those who have sent in questions will be called upon to put their question verbally to the panel; after the panel have dealt with it the questioner may, if he wishes, answer back. It may, of course, be necessary to limit the number of questions put forward.

Questions should be on debatable matters and not matters of fact.

I.E.S. President and Regional Chairmen

Session 1949-50

THE PRESIDENT

At the beginning of his career Dr. J. N. Aldington was trained as an analytical chemist, and it was not until 1928 that he began the work on applied physics and electrical discharges through gases for which he has since become well known. He began his service with Siemens Electric Lamps and Supplies, Ltd., in 1923 and took charge of their laboratories at Preston in 1925. He became assistant works manager in 1938 and last year he was appointed to the board of the company as director of research.

Dr. Aldington is a member of a number of other scientific societies and has published numerous papers on electric light sources. Away from his work he is very keen on gardening, and of recent years, owing to pressure of work, tennis has taken the place of golf as his recreation.

Dr. J. N. Aldington
(President, 1949-50).

CHAIRMEN OF CENTRES AND GROUPS

Bath and Bristol Centre

Mr. W. C. Bowler, M.I.E.E., entered the electric supply industry in 1904 as a pupil at the Bath Corporation electricity works. During the first world war he served with the London Electrical Engineers, R.E. After a period with a firm of consulting engineers he was appointed engineer and manager of the Warmley U.D.C. electricity department in 1930. Last year he was appointed district manager of Severn Vale District Electricity Board.

Birmingham Centre

Mr. P. Hartill, A.M.I.E.E., F.I.E.S., joined the Revo Electric Company in 1931 and, apart from a brief period at their London office, has been at Tipton ever since. He was appointed to the

Mr. W. C. Bowler.

Mr. P. Hartill.

Mr. J. S. Childs.

Mr. H. D. Purvis.

Mr. A. MacGregor.

Mr. A. G. Smith.

lighting department of the company in 1936, shortly after which, having become a member of the I.E.E., he took the inter. and final examinations of the C. and G. in illuminating engineering. He has read a number of papers to I.E.S. centres, and last session presented a paper on the manufacture of fittings at a meeting in London.

Cardiff.

Mr. J. S. Childs joined the staff of the South Wales Electrical Power Company in 1916, being appointed district representative in 1931, later becoming district manager. During the last war he was engaged on power and lighting work for the Ministry of Supply. Last year he was appointed district commercial manager under the South Wales Electricity Board.

Edinburgh Centre

Mr. H. D. Purvis served his apprenticeship with Messrs. James Kilpatrick and Son, Ltd., after which he was for ten years engineer in charge of lighting installations. Between the wars he carried out many large textile lighting installations on the Continent. Since 1938 he has been the firm's engineer and manager at their Edinburgh office.

Glasgow Centre

Mr. Alex MacGregor entered the lighting field in 1935 with the Glasgow Corporation lighting department, and joined the G.E.C., Ltd., in 1937. During the war he was engaged on harbour installations and carried out work on light absorption of smoky atmospheres with the late Mr. T. Nisbet. Mr. MacGregor is well known in Glasgow for his activities in connection with amateur drama.

Leeds Centre

Mr. A. G. Smith, A.M.I.E.E. was a member of the North Midland Centre when it was formed in 1937. After serving an engineering apprenticeship at Tyneside he served ten years with the Yorkshire Electric Power Company. He joined the northern staff of the Benjamin Electric, Ltd., in 1937, and is now their northern area manager. Last year he made a tour of South Africa, Rhodesia and Kenya in connection with the development of lighting business.

Leicester Centre

Mr. F. Jamieson, A.M.I.E.E., received his early training with Sangamo-Weston, transferring to Standard Telephones and Cables in 1939. He joined the E.L.M.A. Lighting Service Bureau, London, in 1946.

He has specialised in shop and store lighting and in 1947 was appointed E.L.M.A. Lighting Service Bureau Engineer for the Central England area,

Mr. F. Jamieson.

Mr. C. C. Smith.

Mr. F. J. R. Makin.

Mr. A. J. Ogle.

Mr. R. H. Ellis.

Mr. H. B. Leighton.

where his scope was widened to include lighting investigations into the chief Midland industries.

Liverpool Centre

Mr. C. C. SMITH, A.M.I.E.E., served his apprenticeship with the Liverpool Corporation Electric Supply Dept. At the outbreak of war he joined the Royal Engineers being demobbed in 1945, with the rank of major. In December, 1945, he rejoined the Liverpool Corporation Electric Supply Department and in April, 1947, was appointed City Lighting Engineer. Mr. Smith is on the council of the A.P.L.E. and chairman of their Lancashire section.

Manchester Centre

Mr. F. J. R. MAKIN served his apprenticeship with Messrs. George Hill and Co. on completion of which he was appointed manager of the Ormskirk Electric Supply Company. During the first war he served with the R.E.s. In 1920 he was appointed director and manager at Messrs. George Hill and Co. becoming chairman and managing director in 1937. He is an active member of the Electrical Contractors' Association.

Newcastle Centre

Mr. A. J. OGLE, B.Sc., A.M.I.E.E., F.I.E.S., has made a particular study of street lighting and is now in charge of street lighting for the North Eastern Electricity Board. Mr. Ogle studied at the Rutherford College, Newcastle, and at Durham University. After a period gaining experience in electrical engineering and contracting he joined the North Eastern Electric Supply Company.

Nottingham Centre

Mr. R. H. ELLIS entered the lighting industry in 1938 when he joined Crompton Parkinson Ltd. as manager of the Supplies Division of their Nottingham branch. He is an active member of the Nottingham branch of the Incorporated Sales Managers' Association and vice-president of the local branch of the British Legion.

Sheffield Centre

Mr. H. B. LEIGHTON, M.A., F.R.I.B.A., studied architecture at the University of Sheffield, obtaining the diploma of the university in 1913. From 1914 to 1930 he gave part-time instruction on building construction at the university. He was the R.I.B.A. Essay Medallist and Prizeman in 1920. He was awarded the Fellowship of the R.I.B.A. in 1934. At present he is in private practice as an architect and lecturer in architectural subjects at the university.

Huddersfield Group

Mr. M. E. BROADBENT, A.M.I.E.E., was apprenticed to his father's firm of electrical engineers, becoming managing director of the firm in 1938 at the age of 30. He is chairman of the Huddersfield branch of the E.C.A. Mr. Broadbent is also actively connected with Congregational Church work.

Swansea Group

Mr. G. J. HIGGS, A.M.I.E.E., the first Chairman of the newly formed Swansea Group, received his early training with the G.E.C. at Coventry. In 1932 he went to South Wales, and this year he was appointed District Commercial Manager of the Swansea District.

Mr. M. E. Broadbent. Mr. G. J. Higgs.

New Lighting Installations

Lighting in a Dress Shop

In designing what they describe as their "Young Liberty" shop, Liberty and Co., of Regent-street, have introduced an ultra-modern style of decoration which is intentionally in sharp contrast to the Tudor style in which the remainder of the building is designed. The idea is to dispel from the minds of young women shoppers the notion that the clothes sold in Liberty's are traditional; to help achieve this a quite different atmosphere from other parts of the shop is created by establishing a contemporary environment in which modern lighting plays a considerable part. This modern setting was designed by Mr. Hulme Chadwick, the architect, who has used concealed fluorescent lighting to create a soft, feminine atmosphere.

The shop consists of a gallery about one hundred feet long with a display area on one side lighted with fluorescent lamps concealed by a false ceiilng. The facing wall is occupied by wall cupboards and small accessory display panels (not shown in the illustration on this page). These accessory panels are lighted from behind and being open at the top contribute indirect lighting to the lighting of the gallery. All the lighting of the gallery is in fact indirect, there being no visible fittings in the gallery itself.

The accessory panels make use of lamps of "natural" colour, but the display wall is lighted with "warm-white" tubes mounted in the false ceiling. No spotlights are in general use, but points have been installed so that spotlights can be used for mannequin parades. The stage, which is in the centre of the display wall, is fitted with five spotlights, and it is intended later on to instal coloured lighting in the small proscenium.

The annexe at the end of the gallery is lighted by means of special fittings, each containing two semi-circular 12-inch radius warm-white fluorescent tubes to give indirect lighting, with a tungsten lamp in the centre to give direct lighting.

The lighting was installed by the engineering department of Liberty and Co., Ltd.

The interior of the 'Young Liberty' dress shop showing the use of lighting to produce a modern atmosphere.

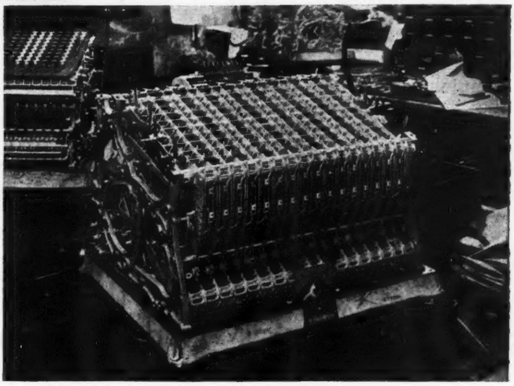
Lighting for Detail

The Nottingham factory of the Burroughs Adding Machine Company is in an old building which has been modernised.

Some idea of the intricate assembly work carried out in the factory is gained from the close-up view of a machine taken under the new lighting, which was designed and installed in consultation with lighting engineers of the Metropolitan Vickers Electrical Co., Ltd.

The fluorescent lighting providing 15/18 lumens per sq. ft. has been so successful that local lighting has been largely superseded, as will be seen from the photographs below.

(Above). The interior of the Burroughs Adding Machine factory.



(Right). Showing the fine detail to be lighted and the excellent results obtained.

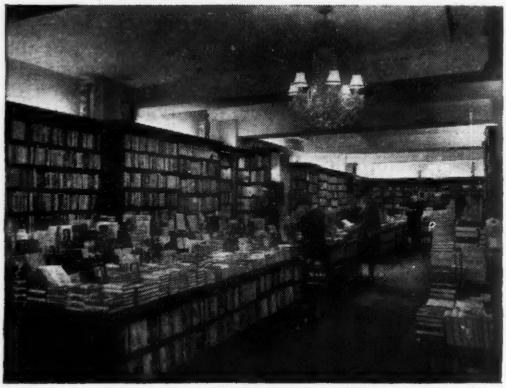
Lighting a Bookshop

The proper lighting of a bookshop is governed not only by the layout of the shop itself but also by a number of less calculable factors such as the type of books displayed, the type of customer catered for, and last but not least the tradition and atmosphere of the place. When, therefore, the management of Hatchards, the well-known and old-established bookshop in Piccadilly, decided to replace with fluorescent lighting the old tungsten installation, they discovered that a certain amount of experiment was necessary before the right answer could be found.

The first experiment was to mount a number of semi-decorative fittings along the ceiling at right angles to the axis of the shop; although enough light was thereby produced, there was too much glare and the effect was not in keeping with the dignity of Hatchards.

The directors then decided to try the effect of concealing the lamps along the tops of the bookshelves, which, as can be seen from the picture, run in an almost continuous line round the walls of the main shop. The result was to the entire satisfaction of management and customers alike: by reflection from the white ceiling an even, mellow light, restful to the eyes but quite adequate for searching and browsing, pervades the shop.

Two period glass chandeliers, the only visible sources of light, were then added, more with the idea of maintaining a "pre-fluorescent" atmosphere than to



Fluorescent lighting in Hatchards bookshop, Piccadilly.

provide extra light. The adjacent stationery department is similarly illuminated.

The installation in both rooms consists of 5 ft., 4 ft., and 3 ft. Osram warm white lamps in G.E.C. single-lamp fittings.

Lighting a Zinc-Plating Plant

In industrial premises where specialised processes are carried out many adjacent fittings, even though not directly involved in the work, must have particular qualities if they are to function at maximum efficiency under circumstances which are frequently severely testing. An example of this is seen in the Works of British Coated Sheets, Ltd., at Ellesmere Port, where special corrosion-resisting B.T.H. lighting fittings have been installed over a zinc-plating plant.

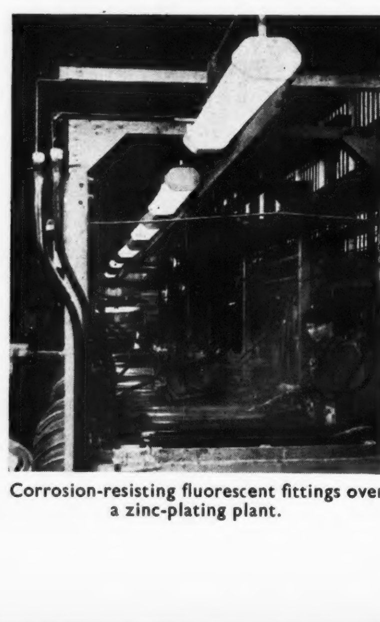
These fittings are of plastic construction with rubber end-covers which completely seal—and therefore protect—the interiors. They are designed for purposes where acid fumes and other damaging vapours may be present, and are therefore admirably suited to installations such as that described here.

Seven fittings are used, each housing one 5 ft. 80-watt fluorescent lamp. They are mounted at a height of 7 ft. from the ground and about 4 ft. above the actual plant. This arrangement provides a lighting intensity of 12-15 lumens per square foot, highly satisfactory for allowing closer inspection of the process—the primary reason for which the scheme was installed.

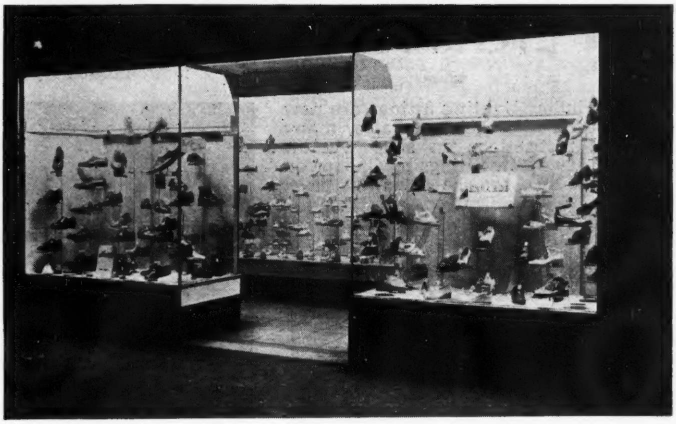
Shop Window Lighting

After the war it was realised by Messrs. Lennards, Ltd., the well-known footwear specialists, that by the time lighting was permitted again it would be advisable to make use of the developments in window lighting technique, particularly in regard to fluorescent tubes and fittings. Anticipating the eventual lifting of the ban on window lighting, provisional plans were made for fluorescent lighting schemes designed in relation to the window displays. The Estates and Window Display Department of Lennards collaborated with the Lighting Department of Crompton Parkinson, Ltd., to develop and perfect a system combining direct and indirect lighting revealing the style, colour and fine points of the footwear displayed.

Effectiveness was ensured by giving attention to the correct selection of the colours and texture of the window



Corrosion-resisting fluorescent fittings over a zinc-plating plant.



Fluorescent shop window lighting for a footwear display.

walls, ceiling, and background. These factors were considered in close relationship to the different shades of light that could be obtained from fluorescent tubes. After experiments involving various combinations of shades and textures of reflecting surfaces, and colours of light, it was decided that "warm-white" tubes with selected reflecting materials would give the precise effect required.

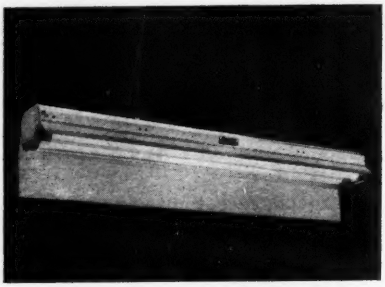
The scheme developed, which is now in use, consists generally of Crompton fluorescent fittings with 80-watt "warm-white" tubes completely concealed from onlookers.

Practically all the new window lighting equipment was installed in less than a fortnight. When Mr. Gaitskell announced the relaxation of the lighting restrictions, Messrs. Lennards Ltd., wanting to have most of their windows fitted with the new lighting equipment ready for the April 2 switch-on, called in Crompton Parkinson Ltd. to supply the materials and supervise its installation by local electrical contractors throughout the country.

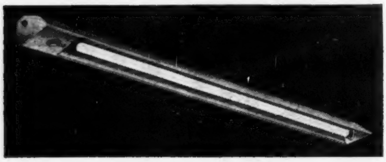
With the lighting-up date only a fortnight after the announcement of the relaxation of shop window lighting restrictions, the installations had to be completed at very short notice. This task involved individual attention to every one of the more than 120 shops scheduled for new window lighting. Everything went according to plan, some installations being finished within a week; and, except for a few where the electricity supply had to be changed over, all the shops concerned were fully illuminated at dusk on April 2. Acknowledgment is due to Messrs. Lennards Ltd. for permission to publish this information.

LIGHTING FITTINGS

Shop window lighting fittings are now coming back into their own after many years of restrictions on shop window lighting. Two new fittings by CROMPTON PARKINSON LTD., are shown on this page. The AA/BA type fitting is available for use with 40- or 80-watt lamps, singly or



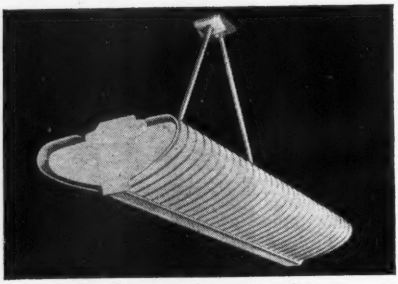
Crompton shop window lighting fittings. *Above* AA/BA; *Below* AD/BD fitting.



in pairs, and is designed for concealed lighting. The AD/BD fitting is designed for small windows and for vertical application from window sides or behind a glazing frame. It can also be effectively applied to show-case lighting and for boosting up light behind displays for silhouette effects.

The G.E.C., LTD., also announce the introduction of twin-lamp fluorescent fittings for shop windows, the fittings being available for 5-ft., 4-ft., and 2-ft. lamps. The fittings are of identical cross section so that different sizes may be butted together to form the required overall length. They can be fitted with hinged louvre frames.

A new decorative fitting, announced by SIEMENS ELECTRIC LAMPS AND SUPPLIES, LTD., the FTF 2252 is the prototype of a number of new fluorescent fittings shortly to be released. Designed for two 20-watt or 40-watt 2-ft. lamps

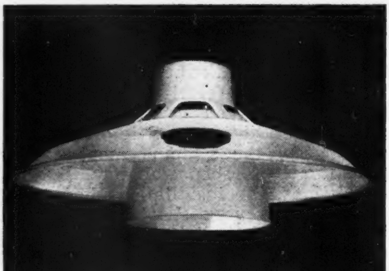


New Siemens decorative fitting.

the fitting embodies shaped opal "Perspex" side panels upon which pastel-coloured lines have been machined. The result is a very pleasing appearance, the finished "Perspex" having something of the character of the lined champagne glass which was at one time popular for tungsten lighting fittings.

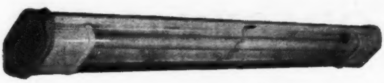
The BENJAMIN "Benflux" fitting for general lighting in small offices, shops, etc., has been redesigned. The shade is now made in Beetle plastic and is of a more modern shape than the former glass shade. It is made without a lip and is retained in the "Crysteel" reflector by means of a three-legged spring attachment which locates inside the hole at the top of the shade. There are two sizes of this new "Benflux," 12-in. for 40/60-watt lamps and 14-in. for 100/150-watt lamps. Prices are 20s. 6d. for the 12-in. complete, and 29s. 3d. for the 14-in.

On p. 242 of this issue reference is made to an installation making use of



Benjamin Benflux fitting.

special B.T.H. corrosion resisting fittings for industrial applications. This fitting (illustrated below) is for use with one or two fluorescent lamps. It is of plastic construction with the exception of two



B.T.H. Corrosion proof fitting.

rubber end-covers which completely seal the interior of the fitting from the surrounding atmosphere, thus protecting it from fumes, dust, and steam. The fitting can be supplied with or without an internal anodised aluminium reflector and is available in lengths of 5 ft. for use with one or two 80-watt lamps, or in lengths of 4 ft. for use with 40-watt lamps.

K. M. G. (ENGINEERS), LTD., announce the introduction of their "Hanover" and "Manchester" fittings. The former, a development of the "Portman" twin 2-ft. fittings, is for a single 4-ft. 40-watt lamp having a voltage selector panel at one end and a glow starter at the other. An aluminium centre tube houses the choke, condenser and radio suppresser.

Trade Literature

THE EDISON SWAN ELECTRIC CO., LTD.—Brochure entitled "This is Ediswan," an illustrated description of the company's activities.

B.T.H. Co., LTD.—Catalogue of "Mazda" shiplighting fittings.

Personal

Mr. R. S. Hazell, G.E.C. lighting engineer in Bristol for a number of years, has joined the Revo Electric Co., Ltd., as their technical representative for Bristol and District. Mr. Hazell is hon. sec. of the I.E.S. Bath and Bristol centre.

Messrs. Rettig and Knox announce that their Bristol office is now at the Refuge Assurance Building, 18, Baldwin Street, Bristol, 1. (Bristol 23316).

County Hall, Westminster, stands out brilliantly against the night sky as BTH floodlighting is switched on again on the recent occasion of the L.C.C.'s Diamond Jubilee. This lighting was originally installed before World War 2.

Printed by ARGUS PRESS, LTD., Temple-avenue and Tudor-street, London, E.C.4, England.

mely
t is,
ed at
ntrol
angle
walls.